SENSORY INFORMATION FROM AFFERENT NEURONS

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PROGRESS REPORT #10

For the period

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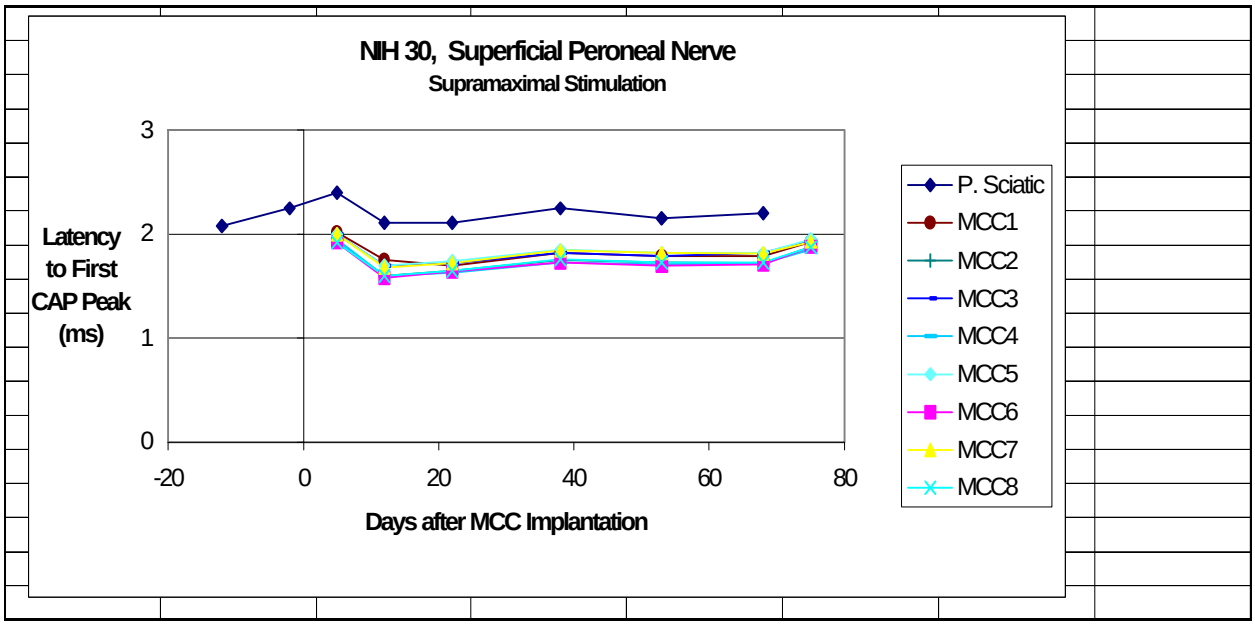
Progress in the Tenth Period

During the present reporting period we implanted the first-stage devices in two additional animals (NIH 32, 33) of a current series designed to test the long-term viability and selectivity of 8-channel Multi-Contact Cuff (MCC) electrode arrays installed on the Sciatic nerve above the knee. Each subject received four single-channel tripolar nerve cuffs, one on the sciatic nerve proximal to the hip joint and three on the tibial, superficial peroneal and sural nerve branches of the sciatic. Cuff dimensions were as in Table 1 of our previous QPR (#9). Each subject was also implanted with EMG electrodes on 6 innervated muscles (Table 1, QPR #9).

The stability of the implanted devices was tested the night after implant and once or twice again in the following two weeks. As for the previous subjects of this series (NIH 29, 30, 31), our protocol specified the implant of an 8-channel MCC and an additional EMG electrode (MG muscle) in a second surgery, 2-3 weeks following the first one. This protocol provides baseline data on nerve status and implant stability prior to installation of the MCCs, in order that any changes that may follow the MCC implantation can be clearly observed and further tracked over the following six months of the experiment. However, we delayed the implantation of the MCCs in NIH 32 and 33 when we observed a rapid decline in the sciatic nerve in NIH 31 during the weeks following its MCC implant, described below.

When the distal nerves or muscles were stimulated under anesthesia over the days and weeks following the MCC implant in NIH 31, the amplitude of the compound action potentials (CAPs) recorded from the MCC and from the proximal Sciatic cuff declined steadily and the latencies to first peak of the CAPs increased, indicating a deterioration in the condition of the nerve. Fig. 1 compares the time course of the signals recorded from the proximal Sciatic and from the MCC electrodes when the Superficial Peroneal nerve was stimulated in two subjects, NIH 30 and NIH 31. Fig. 2 shows a similar comparison when one of the instrumented muscles, Soleus, was stimulated. Similar results were obtained when the other implanted nerve branches or muscles were stimulated. Latency to first peak of CAP measures provide a sensitive assay of the condition of a nerve. It is clear from these data that, whereas the nerve condition in NIH 30 was stable and essentially unaffected by the implantation of the MCC, the nerve condition in NIH 31 was seriously affected.

Although NIH 31 did not show signs of pain or discomfort, on day 45 there was a noticeable weakness in the ankle extensor musculature during free standing and walking. At that point we terminated the experiment in NIH 31, in order to inspect the condition of the nerves and implants and remove tissue samples for pathological investigation. We found that the nerve was somewhat swollen inside the MCC but not inside the other cuffs, and there were a number of unusual white, hard, discrete tissue accumulations inside the MCC, which were always found near electrodes (both recording and indifferent). The pathology lab reported clusters or accumulations of necrotic inflamed material compatible with inflammatory exudate that could reflect mild local infection or possibly remnants/debris from eosinophilic granuloma.



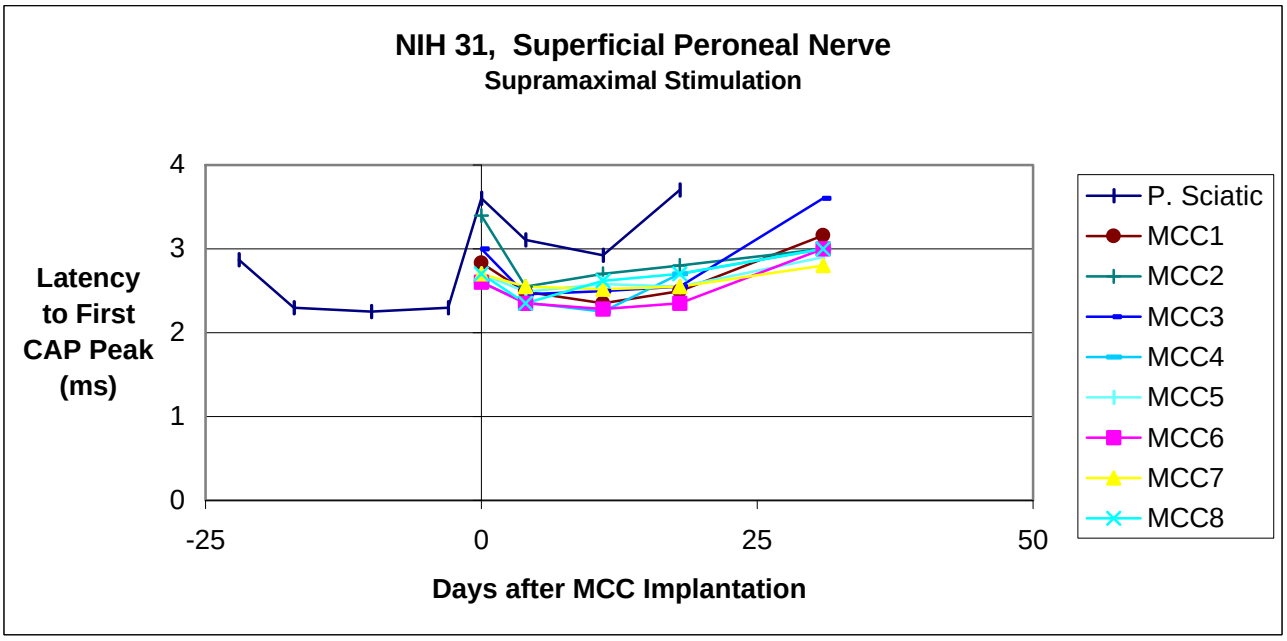


Fig. 1. Latency of first peaks of compound action potentials recorded in NIH 30 (top) and NIH 31 (bottom) in response to distal Superficial Peroneal nerve branch stimulation, measured at periodic intervals before and after the day of MCC implantation (day 0).

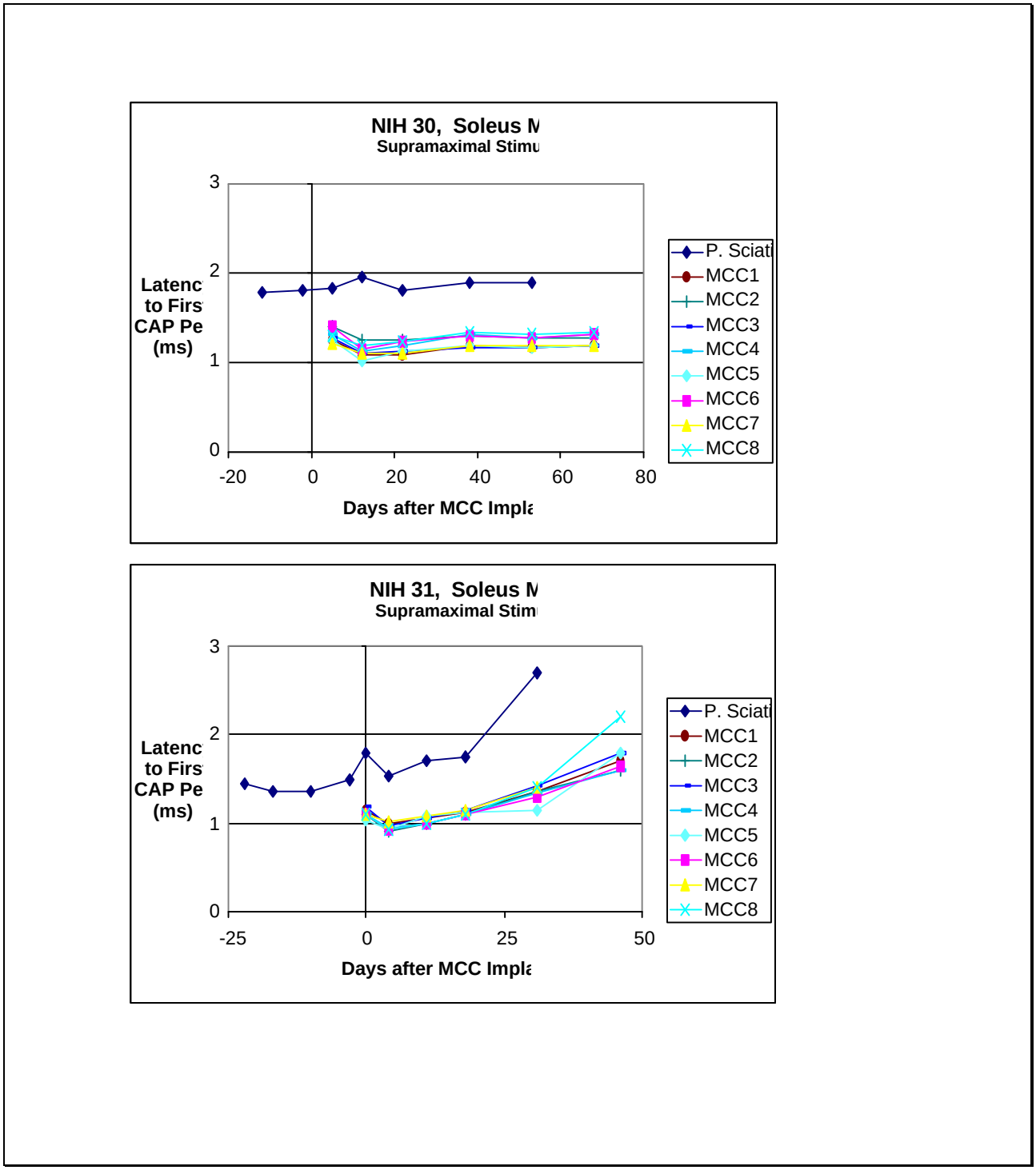


Fig. 2. Latency of first peaks of compound action potentials recorded in NIH 30 (top) and NIH 31 (bottom) in response to distal stimulation near the Soleus muscle nerve entry point, measured at periodic intervals before and after the day of MCC implantation (day 0).

After consultation with the contractor who fabricated the MCC electrodes, our conclusion was that it was likely that remnants of Teflon etching solution were left inside the electrode lead wire jackets which could not be removed by our standard cleaning and sterilization procedure. Our hypothesis is that in NIH 31 this toxic substance subsequently leached out through the silicone, came in contact with the nerve and caused the nerve deterioration and the local tissue reaction. We ordered a replacement set of electrodes and advised the contractor to dip the Teflon-coated wires in etching solution BEFORE cutting the wires and not to allow the cut end of the wires to enter the solution, as this could wick up inside the jacket.

Plans for the Eleventh Period

Once the new electrodes are delivered we will proceed with the MCC implantation in NIH 32 and 33. We will additionally implant NIH 34 and 35 to complete this series. We have negotiated an extension in the time for completion of this contract, at no additional cost, in order to finish the research that was delayed by setbacks reported earlier. In the meantime, we will continue to analyze the selectivity of already recorded data using methods described in our previous Progress Reports.